

Manhattan HVAC Excel Model Audit Report

Step 1 — review only | 22 October 2026

Workbook: Manhattan_HVAC_CapEx_Revised(2).xlsx

Conclusion. The reported base-case costs, energy reductions and financial returns reproduce independently. No material arithmetic discrepancy was found in those results. The workbook is suitable for a hypothetical feasibility study, but its evidence does not yet support an investment approval.

Option C has a small positive base-case NPV; Option B has a negative NPV in all three modeled scenarios. Keep that conclusion conditional on the engineering, repair-cost, lease and tax assumptions. The control weaknesses on page 5 should be corrected in Step 2. No workbook content or formatting was changed during this audit.

Independently reproduced base-case results

Measure and unit	B — Full	C — Partial
Initial funding (USD)	\$5,000,000	\$1,669,000
HVAC electricity saved (kWh/year)	1,147,200	477,000
HVAC electricity reduction	37.6934% → 37.7%	15.6727% → 15.7%
Year 1 pretax operating savings (USD)	\$399,440	\$190,400
Year 1 after-tax incremental cash flow (USD)	\$330,054	\$153,405
Dated NPV at 8.5% (USD)	−\$1,754,620.45	+\$68,530.64
Dated IRR (XIRR)	−0.38265%	9.44427%
Simple / discounted payback (years)	Neither within 10 years	6.5096 / 9.1185
10-year net cash ROI	−2.0313%	56.2691%
10-year net incremental cash flow (USD)	−\$101,566	+\$939,131

Trace: CapEx!F25/I25 and F28/I28; Energy!G19:H22 and G29:H29; Cash Flow!E54/E76 and E89:F94. Display rounding explains the shorter dashboard figures; monetary recalculations agree within \$0.01. ROI = total Years 0–10 incremental cash flow ÷ initial funding. Payback figures interpolate the first cumulative crossing.

Timeline: Year 0 is 31 December 2026; Years 1–10 end on 31 December 2027–2036. Cash Flow!D7:N8 contains 11 observations, including the initial outlay once. Option A is the comparison baseline, so its incremental NPV is zero; its operating and future capital costs are still included.

2. Verification method and worksheet coverage

Independent calculation: a separate Python calculation rebuilt the itemized budgets, load-bin electricity, depreciation, annual owner cash flows and incremental cash flows from the workbook inputs. It used actual dates for discounting and a numerical root solver for XIRR. All 72 comparison checks passed, including all 25 two-variable sensitivity cells and all 20 one-variable outputs.

Internal calculation check: a separate spreadsheet engine recalculated all 1,625 formula cells without a material difference from the saved results. All 14 existing audit statuses passed in each of the three standard scenarios. Those checks establish consistency, not the validity of the assumptions. No external-workbook links or base-case formula error values were found. Desktop Microsoft Excel was not available.

Scenario / NPV (USD)	B — Full	C — Partial
Base	−\$1,754,620	+\$68,531
Optimistic	−\$514,312	+\$621,752
Downside	−\$3,908,537	−\$838,052

Scenarios!E8:F10 agrees with independent calculations. With the stated 50% / 20% / 30% subjective weights, NPVs are −\$2,152,734 and −\$92,800. These weights are judgments, not measured probabilities.

Worksheet	Review result and relevant cells
Summary	E8:F16 correctly links the main outputs. The single chart uses C51:C61 and D51:E61, linked to cumulative discounted cash flow. Its Year 10 endpoints match NPV.
Assumptions	E5 switches all three cases correctly. E12 links to J41; a 4,000-hour test updates electricity and NPV. Engineering inputs and financial assumptions remain estimates.
CapEx	F23:F32 / I23:I32 reconcile. Contingency is 10% of real-property items, excluding computer and training costs. The prices are not independently validated bids.
Energy	F8:H29 has consistent ton-hours, kWh and cost units. Escalation begins in Year 2. E63:G72 is only an emissions screen.
Tax	D11:N54 arithmetic reproduces the assumed schedules. Book depreciation is separate. Tax eligibility, existing basis and deduction timing still need evidence.
Cash Flow	D16:N16, D27:N27, D38:N38 and incremental rows 54/76 reconcile year by year independently. Dated NPV includes Year 0 correctly.
Scenarios	E8:F10, D44:H48, F61:I65 and E51:E52 reproduce. Invalid-input robustness needs improvement; see page 5.
Audit	E8:E21 passes the standard cases, but ratio tolerance and aggregate-only comparisons are too weak.
Sources	E9:E22 was reviewed against primary sources. Most references give context, not evidence for the specific inputs; see page 6.

3. Engineering credibility

Building scale: 500,000 ft² is credible for a hypothetical large office. DOE's reference large office is 498,588 ft² [R1]. This supports the scale, not a particular Manhattan building's layout or cooling load. Assumptions!E9:E10 implies 416.7 ft²/ton and 28.8 Btu/h per ft² ($1,200 \times 12,000 \div 500,000$). The 1,200 tons is a planning assumption, not a verified equipment selection.

The energy calculation is dimensionally correct

For each load bin: installed tons $\times$ load fraction $\times$ hours $\times$ kW/ton = kWh. The four bins total 1,950,000 ton-hours, equivalent to 1,625 full-load hours at 1,200 tons. They represent 3,000 operating hours, not 3,000 hours at full capacity. Auxiliary electricity = rated kW $\times$ average input fraction $\times$ operating hours.

Annual electricity (kWh)	A — Existing	B — Full	C — Partial
Chillers	1,536,000	999,000	1,419,000
Fans, pumps and towers	1,507,500	897,300	1,147,500
Total modeled HVAC	3,043,500	1,896,300	2,566,500

At \$0.20/kWh, electricity savings are \$229,440 for B and \$95,400 for C. Adding maintenance/repair savings of \$195,000 / \$110,000 and subtracting analytics costs of \$25,000 / \$15,000 gives \$399,440 / \$190,400. The 37.7% and 15.7% figures apply to modeled HVAC electricity, not all building energy or heating fuel.

Critical engineering evidence to add in Step 2

Load and performance — Assumptions!C33:G36; E10. Document NYC design weather, occupancy, ventilation, envelope and internal loads. Explain whether the kW/ton values represent individual chillers or the staged plant. Two 600-ton units do not provide a spare 600-ton unit when the full 1,200 tons is needed. Obtain manufacturer performance at the assumed chilled- and condenser-water conditions, or retain explicit estimates pending an audit/simulation.

Efficiency benchmark — Assumptions!F36. The 0.585 kW/ton input matches one DOE part-load-optimized centrifugal chiller threshold for units ≥ 600 tons. That category also requires 0.400 IPLV [R2]. The workbook does not establish that paired rating or validate the assumed part-load curve. Do not describe the full curve as manufacturer-verified.

Auxiliary savings and remaining life — Assumptions!D41:J43; E11:E13. Fans, pumps and towers supply 53.2% of B's savings and 75.5% of C's. The average power fractions therefore need control sequences, airflow/water-flow requirements and operating evidence. Explain how the 20-year-old plant can serve another 10 years under A/C, including overhaul scope, downtime and reliability. The 23-year reference is not a fixed retirement date.

4. Decision-critical assumptions and Step 2 actions

Severity: “Critical” here means evidence needed before relying on an investment recommendation. It does not mean that the base-case arithmetic is wrong. The items below can materially change the ranking or the interpretation.

C1. Budget, repairs and future replacement scope

Cells: CapEx!D8:I24; Assumptions!E47:G56. The \$5.000 million and \$1.669 million totals reconcile, but no comparable priced scope establishes their accuracy. Obtain budget quotes with quantities, NYC labor/rigging, exclusions and contingency basis. Reconcile annual repairs with capital overhauls to prevent scope double counting. Explain whether future work changes efficiency or useful life.

A’s \$800,000 Year 3 and \$600,000 Year 7 allowances become \$840,500 and \$695,816 after escalation. As a diagnostic only, removing those A expenditures while holding the other assumptions fixed changes C’s NPV to **−\$950,575**. This is not a proposed baseline; it shows why avoided future capital requires evidence.

C2. Avoidable energy price and owner benefit

Cells: Assumptions!E22, E61:E63, E19:E20, E81:E83. The \$0.20/kWh marginal saving is an estimate. EIA’s July 2026 NY commercial average is 24.18 cents/kWh [R3], but it is not the avoidable rate on a particular bill. Con Edison demand-billed accounts have kWh and kW charges [R4]. Use bill components and interval demand data; document escalation, discount rate and lease recoveries. A 50% retention test reduces C’s NPV to **−\$426,932**.

C3. Tax classification and tax capacity

Cells: CapEx!J8:J21; Assumptions!E18, E24, E27:E28, D90:I90; Tax!C57:C61. The 39-year mid-month schedule, five-year computer MACRS and training deduction reproduce mathematically. However, not every HVAC improvement must receive 39-year treatment: qualified interior improvements and eligible Section 179 HVAC property require separate classification [R5]. Current IRS instructions also allow 100% bonus depreciation for qualifying property acquired and placed in service after 19 January 2025 [R6].

Create an asset-by-asset classification note, including existing tax basis, removal costs, repair versus capital treatment, training timing, taxpayer eligibility and elections. If retaining no bonus depreciation, state the assumed election or ineligibility. Justify the illustrative 28% rate and immediate deduction use. Do not automatically apply accelerated deductions to the entire budget.

C4. Scope of the recommendation

Cells: Summary!C19:F23; Cash Flow!C100:C103; Energy!E63:G72. C’s break-even initial funding is only \$1,741,161, about 4.3% above base; its break-even electricity price is \$0.1724/kWh. Both were reproduced. Keep C as the candidate for further validation, not an unconditional approval. B’s negative 10-year NPV does not establish lifetime uneconomic performance: remaining service value and later tax shields are excluded.

The 2030 office limit and electricity/gas coefficients agree with the cited NYC rule [R7]. The screen omits 2035–2036 inside the financial horizon and does not establish building compliance. Document occupancy, applicable rules and incentive eligibility before changing exclusions [R7–R9].

5. Exact control corrections and audit limitations

Priority / finding	Cells and recommended Step 2 change
Moderate Unphysical inputs can pass every audit check.	Assumptions!E66:E68 and E76:E78 allow values up to 100. Setting E66=3 produces Energy!G21 = −398,100 kWh/year; setting E76=3 produces Energy!G25 = −\$225,000/year. All 14 audit checks still pass. Add physically meaningful validation and checks for nonnegative modeled energy/O&M; in every scenario. Do not silently cap savings and hide invalid inputs.
Moderate Ratio tolerance is too loose.	Audit!E18:E19 applies 0.01 to fractional totals: a one-percentage-point tolerance. E86=0.505 makes scenario weights total 1.005, yet E18 reports PASS. Use 1E-8 for these two ratio checks, e.g., =IF(ABS(D18)<=1E-8,"PASS","REVIEW"). Retain \$0.01 for monetary checks.
Moderate Annual errors can cancel.	Audit!D10:D11 and D16:D17 compare sums across all years. Replace each with the sum of absolute year-by-year residuals, e.g., SUMPRODUCT(ABS('Cash Flow'!D27:N27-'Cash Flow'!D16:N16-'Cash Flow'!D54:N54)). Apply the analogous comparison to C and scenario reconstruction.
Minor robustness Forced zero-cost input breaks scenario decomposition.	Scenarios!E23:N23 and E30:N30 divide by Assumptions!E70. Forcing E71=0 yields #DIV/0! in the scenario table. Zero is already outside the intended 0.01–100 validation range. Add a clear invalid-input state or compute unit tax shields from unscaled basis so a pasted invalid value cannot contaminate all cases. Guard ROI/XIRR when their prerequisites fail.
Minor documentation Payback and dated returns need clear interpretation.	Keep Cash Flow!E89:F97 formulas. Add “interpolated after-tax cash-flow payback” to Summary!C13:C14. C crosses at Year 7 / Year 10 if cash is received only at year-end; 6.51 / 9.12 assumes within-year interpolation. Clarify that this is not initial CapEx ÷ Year 1 operating savings.
Moderate evidence Input-to-source traceability is incomplete.	Sources!D8:F22: add publication/access dates, relevant page/table, input-cell mapping and an explicit “estimate / benchmark / rule” tag. E8 names a reconstruction PDF, not independently verified input evidence. Replace the S09 URL with the working link on page 6. Recheck S10 before relying on it.

What passed: the original scenario controls, ventilation-hours link, tax-rate change and retention change updated the dependent results. The chart bindings and displayed curves agree with their linked cash flows. Key calculation areas from all nine sheets were rendered and inspected.

What remains unverified: actual equipment condition, bids, load profiles, tariff savings, lease terms, tax eligibility and building compliance. A site audit or calibrated simulation was not performed. Excel-native recalculation, print pagination and the uniqueness of every possible XIRR root under arbitrary edits were not tested. Option C has a negative Year 5 cash flow; retain NPV as the primary ranking measure.

XNPV uses actual days/365 [R10]. Periodic NPV references in Cash Flow!E96:F96 are \$977.02 / \$561.21 higher because of leap-day timing. That difference is expected, not a formula error. Depreciation affects taxes; it is not counted as a cash payment.

6. Primary-source review and report boundaries

Links below identify the sources used in this audit. Access/retrieval attempts: 22 October 2026. A source’s existence does not verify the hypothetical building inputs. “S” numbers refer to the workbook Sources sheet; “R” numbers refer to this report.

Ref. / workbook	Primary source, evidence and limitation
R1 / new	DOE — Commercial Reference Buildings . Large Office table: 498,588 ft², 12 floors. Scale benchmark only; no Manhattan load calculation.
R2 / S01, row 9	DOE FEMP — Purchasing Energy-Efficient Electric Chillers . October 2024 requirements; Table 3.2 and life-cycle assumptions. Supports benchmark context, not the load-bin curve.
R3 / S02, row 10	EIA — Electric Power Monthly, Table 5.6.A . July 2026 data, released 24 September 2026. NY commercial average 24.18 cents/kWh; not a marginal tariff. Archive this dated table.
R4 / S03, row 11	Con Edison — Electric Rate FAQs (English) . Demand billing discussion supports separating kW demand from kWh charges. No building bill was supplied. Workbook uses the Spanish URL.
R5 / S08, row 16	IRS — Publication 946 (2025) . Nonresidential property, conventions, qualified improvements and Section 179. Supports rules; does not establish this owner’s eligibility.
R6 / new	IRS — Instructions for Form 4562 (2025) . Special depreciation allowance / election-out provisions. Verify eligibility and elections for assumed January 2027 service.
R7 / S05, row 13	NYC DOB — 1 RCNY 103-14 . PDF pp. 7 and 12: 2030 office limit 0.002690852 tCO ₂ e/ft²; electricity 0.000145 tCO ₂ e/kWh; gas 0.00005311 tCO ₂ e/kBtu. Later-period requirements need separate review.
R8 / S06–07, rows 14–15	NYC — Local Law 97 of 2019 ; DOB LL97 guidance . Legal and applicability context. No conclusion on this hypothetical building’s exceptions or adjustments.
R9 / S04, row 12	Con Edison — Commercial efficiency upgrades . Program page reviewed; no award or eligibility verified. Workbook correctly books no rebate.
R10 / S14, row 22	Microsoft — XIRR function . Dated returns use a 365-day basis; cash flows must include positive and negative amounts.
R11 / S09, row 17	Kim & CaraDonna — ComStock Chiller Replacement . NREL/TP-5500-95003, August 2025, 58 pages. Working replacement link verified. Methodology context, not a site savings guarantee.
R12 / S10, row 18	DOE — Preventative Maintenance for Commercial HVAC Equipment . Retrieval failed (502); full content not verified. No maintenance dollar estimate is validated by this reference.
R13 / S11–12, rows 19–20	NYC DCAS — 22 Reade procurement ; Queens procurement . Notices dated 9 April 2025. Different scope; neither establishes this model’s installed cost per ton.
R14 / S13, row 21	DOE — Electric Motor Standards, May 2023 . Regulatory document exists. It does not substantiate the workbook’s fan/pump average power fractions; add relevant technical evidence.

Original preserved: SHA-256

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Step 1 ends here. The listed changes are recommendations only; Step 2 has not started.